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PATENT SPECIFICATION

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(72) Inventor EDWARD GUNSTON TATTERSALL

(19)

(54) IMPROVEMENTS IN OR RELATING TO WATER-BORNE CRAFT

(71) We, HOVERMARINE TRANSPORT LIMITED, of Hazel Wharf, Hazel Road, Woolston, Southampton, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to water-borne craft, that is to say, craft which at least in one period of operation are supported, at least in part, by water.

Thus the term "water-borne craft" as used herein not only includes boats and ships but also amphibious craft such as flying boats. The term is also intended to include gas-cushion craft for operation over water, wherein, in operation, at least part of the craft is immersed in water. An example of such a craft comprises a "sidewall" gas-cushion craft one form of which is described in Britisn Patent Specification No. 1,277,883.

According to the invention, a water-borne craft is provided with laterally-extending outlet means for discharging a curtain of water from the craft at a position remote from the craft centre of gravity so as to cause a local change of water pressure on an adjacent immersed portion of the craft, whereby an attitude-changing force is applied to the craft at said immersed portion and about said centre of gravity.

The invention allows unwanted pitch and/or roll movement of water-borne craft to be corrected.

The invention also allows manoeuvring forces to be applied to water-borne craft.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, wherein:—

Figure 1 is a side view of one water-borne craft,

Figures 2 and 3 are enlarged fragmental views of the stern end of the craft of Figure 1,

Figure 4 is a bow-on view of another water-borne craft,

Figure 5 is a side view of a further water-borne craft,

Figure 6 is a fragmental side view of the stern end of another water-borne craft,

Figure 7 is an inverted plan view of a further water-borne craft, and

Figure 8 is a side view of yet another water-borne craft.

With reference to Figures 1 to 3, a water-borne craft in the form of a high speed passenger launch 1 comprises a hull 2 having a stepped stern portion defining a downwardly-presented convex surface 3. The launch 1 is propelled by a pair of water screws 4 driven by engines 5 through parallel disposed shafts 6 and is steered by a central rudder 7.

A water pump unit 8 is disposed in the hull 2. The pump unit 8 has a water inlet extending from the bottom 9 of the launch 1 and a water outlet 10 terminating at the step 11 of the stern portion of the hull 3. The stern end of the water outlet 10 extends laterally across the step 11 and is thus disposed at a position remote from the craft centre of gravity (*C.G.*). The pump unit 8 comprises an impeller and a motor driving the impeller. A control flap 12 is disposed adjacent the discharge end of the water outlet 10 and one end of the flap 12 is mounted on a support spindle 13 rotatably attached to the hull 2 by a laterally-spaced pair of support brackets (not shown). The spindle 13 and the control flap 12 together rotate about an axis extending substantially normal to the fore and aft axis of the launch 1. The control flap 12 is movable about this axis from a substantially vertical position

(Figure 2) to a substantially horizontal position (Figure 3) by a fluid-operated actuator 14.

When in a substantially horizontal position the flap 12 is disposed in a shallow recess 3a whereby its bottom surface is substantially flush with the surface 3.

The water pump unit 8 and control flap 12, plus their associated components provide means for discharging a curtain of water from the launch 1 and the hull 2 itself provides means for using the curtain of water to cause a local change of water pressure on an immersed portion of the launch 1, whereby an attitude changing force is applied to the launch at the immersed portion and about the centre of gravity *C.G.*

Thus, with reference to Figure 2, should the launch 1 encounter conditions tending to cause the stern of the launch to pitch rearwardly, the control flap 12 can be disposed substantially vertically so as to direct water discharged from the outlet 10 downwardly, generally normal to the path of water flowing along the bottom of the launch 1 in the form of a water curtain or barrier.

This water curtain will result in a local increase in water pressure immediately forwardly of this curtain or barrier, as represented by the arrows 15. This increase of water pressure will generate a restoring force 16 which acts about the centre of gravity *C.G.* of the launch (Figure 2) and tend to restore the launch to its original attitude.

On the other hand, with reference to Figure 3, should the bow of the launch pitch forwardly, the control flap can be rotated so as to cause water discharged from the outlet 10 in a sheet-like form to "Coanda" along the downwardly-facing convex surface 3 of the hull 2. This "Coanda" flow along the convex surface 3 will tend to reduce the water pressure acting on the surface, as represented by the arrows 17, giving rise to a restoring force 18 acting about the centre of gravity *C.G.* of the launch 1 and tending to restore the launch to its original attitude.

Preferably movement of the control flap 12 is automatic and is controlled by means sensitive to substantial changes of attitude of the launch 1. For example, accelerometers or fluid logic sensors may be used to operate the actuator 14.

With reference to Figure 4, alternatively or in addition, the invention may be used to restore a water-borne craft to its original attitude when subjected to roll.

In Figure 4, the hull 26 of a passenger launch 25 has a "V"-shaped bottom. Laterally-spaced pairs of keels wall structures 27 extend longitudinally along a mid-length portion of the hull 26 and on either side of the fore and aft axis of the launch 25.

Water from a pump unit (not shown) may be discharged through one of a pair of water outlets 28 extending laterally between the stern ends of the walls 27 and disposed to discharge water in a forward direction. Should the launch 25 roll to one side, a curtain of water is discharged downwardly and forwardly from the water outlet 28 on that side, so as to result in a local increase in the pressure of water flowing along the path defined by the walls 27 of that side. This local increase in water pressure will give rise to a restoring force acting about the centre of gravity *C.G.* of the launch 25, which force will tend to restore the launch to its original attitude.

Discharge of water from the selected water outlet 28 is preferably controlled automatically as mentioned above.

Figure 5 illustrates a tanker 35 wherein water curtains are discharged in forward directions from two laterally-extending water outlet ducts 36, 37 disposed adjacent the bow and stern of the tanker so as to be longitudinally-spaced from each other. If a curtain of water is discharged from the bow duct 36 as illustrated, this results in a local increase in pressure of water flowing along the bottom of the tanker 35, which increase results in the application of an upwardly acting force on the tanker about its *C.G.* so as to control forward pitch. Similarly, if a curtain of water is discharged from the duct 37 instead, a force will be applied in the opposite direction so as to control rearward pitch.

Figure 6 illustrates an arrangement wherein a launch 45 substantially of the form of the launch 1 of Figure 1, has, instead of a control flap, two separate laterally-extending water outlets 46, 47. The outlets 46, 47 are provided for pitch control. Outlet 46 is disposed to discharge a sheet of water rearwardly over the convex surface 48 of the hull 49 so as to make the water "Coanda" over the surface. Outlet 47 is disposed to discharge a substantially vertical barrier or curtain of water immediately to the rear of the step 50.

As in the previous examples, the discharge of water from the hull 49 of the launch 45 is preferably under automatic control.

Figure 7 illustrates a large ship 65 wherein two longitudinally-spaced water outlets 66, 67 are disposed adjacent the bow and stern ends of the hull 68 and arranged to discharge barriers or curtains of water from the sides of the ship whereby local changes of pressure are used to generate sideways acting forces on the hull 68. Thus turning moments may be applied to the ship 65 about its centre of gravity.

Alternatively or in addition, the ship 65 is

provided with a laterally spaced pair of water jet propulsion units of which the water outlets 69 are shown. The stern of the ship 65 is stepped as shown, and rearwardly of the steps 70 the hull 68 converges to provide outwardly-facing convex side surfaces 71.

The water outlets 69 terminate at the steps 70 and the discharge of water therefrom is varied by control flaps 72 disposed at the inboard sides of the water outlets 69. The control flaps 72 rotate about axes disposed substantially normal to the fore and aft axis of the ship 65. When a control flap 72 is disposed longitudinally it allows a free flow of water from the associated outlet 69 to "Coanda" over the adjacent convex surface 71 whereby water pressure is reduced locally and lateral forces are applied to the stern of the ship 65. When a control flap 72 is disposed laterally it prevents a full flow of water from the associated water outlet 69 so that little or no water flows over the adjacent convex surface 71 and therefore little or no lateral force is applied to the convex surface 71. Thus substantially all the water that is discharged from an outlet 69 is used for propulsive purposes.

As in the above-mentioned example, discharge of water from the ship 65 is preferably under automatic control.

With reference now to Figure 8, the invention may be applied to "side-wall" gas-cushion craft for operation over water. Figure 8 shows such a craft wherein the craft 85 is generally of the form described and illustrated in British Specification No. 1,277,883.

Briefly, the craft 85 comprises a body 86 supported above the water 87 by a cushion 88 of pressurised air formed beneath the body 86. The sides of the cushion 88 are contained by a laterally spaced pair of rigid "side-wall" structures 89 which extend in substantially parallel array along the sides of the body 86 and depend therefrom to dip into the water 87 and provide a cushion seal. The front and rear ends of the air cushion 88 are contained by flexible skirts 90, 91. The rear flexible skirt 91 is inflated by air provided by a fan 92. The lower interior of the front flexible skirt 90 is open to the cushion 88 and is inflated by cushion air. Air forming the air cushion 88 is provided by a laterally-extending row of fans 93 and part of this air is also used to inflate the upper interior of the front flexible skirt 90. The craft 85 is propelled by a pair of water screws 94 and is steered by a pair of rudders 95. Each water screw 94 and rudder 95 is mounted on a sidewall 89.

The rear or stern ends of the sidewalls 89 have stepped portions defining convex surfaces 96. A water pump unit 97 is disposed in each sidewall 89. The units have water inlets 98 extending from the bottom edges of the sidewalls 89 and water outlets 99 terminating at the steps 100 of the stepped portions. The water outlets 99 extend laterally across the steps 100. A control flap 101 similar to the control flap 12 of Figures 1 to 3 is provided adjacent each water outlet 99.

In operation, water is discharged from the water outlets 99 and is used to correct pitch movements of the craft 85 in the same way as described above in connection with Figures 1 to 3. As in the above-mentioned examples, movement of the control flaps 101 is preferably under automatic control.

WHAT WE CLAIM IS:—

1. A water-borne craft provided with laterally-extending outlet means for discharging a curtain of water from the craft at a position remote from the craft centre of gravity so as to cause a local change of water pressure on an adjacent immersed portion of the craft, whereby an attitude-changing force is applied to the craft at said immersed portion and about said centre of gravity.

2. A craft as claimed in Claim 1 wherein said curtain of water is made to traverse the path of water flowing along the craft so as to cause a local increase in water pressure forward of said water.

3. A craft as claimed in claim 1 wherein said curtain of water is made to "Coanda" along the craft so as to cause a local reduction in water pressure.

4. A craft as claimed in Claim 2 wherein said water path is defined by laterally-spaced pairs of wall structures depending from and extending longitudinally along the bottom of the craft.

5. A craft as claimed in Claim 1, 2 or 3 wherein the craft is provided with a stepped stern portion and said curtain of water is discharged from an outlet disposed at the step.

6. A craft as claimed in Claim 5 wherein that part of the stern portion rearward of the step is a downwardly presented convex surface.

7. A craft as claimed in Claim 6 wherein means are provided for varying the direction in which the curtain of water is discharged from normal to the path of water flowing past the step to along said convex stern portion.

8. A craft as claimed in Claim 1, 2 or 3 wherein the craft is provided with a stepped stern portion and said curtain of water is discharged from one of two outlets disposed at the step whereby water may be discharged either downwardly or rearwardly.

9. A craft as claimed in Claim 8 wherein that part of the stern portion rearward of the step is a downwardly presented convex surface.

10. A craft as claimed in Claim 1 wherein said curtain of water is made to traverse the path of water flowing along the craft at two longitudinally spaced positions so as to cause local increases in water pressure forward of each position.

11. A craft as claimed in Claim 10 wherein said positions are beneath the craft.

12. A craft as claimed in Claim 10 wherein said positions are on the side of the craft.

13. A craft as claimed in any of Claims 1 to 12 which, in operation, is supported by a cushion of pressurised gas.

14. A craft as claimed in Claim 13 wherein the cushion is contained by a laterally spaced pair of wall structures extending in substantially parallel array along the body of the craft to depend therefrom to dip into the water and provide a cushion seal.

15. A craft as claimed in Claim 13 wherein the wall structures are stepped, those parts of the wall structures rearward of the steps presenting downwardly facing convex surfaces, and said curtain of water is discharged from outlets disposed at the steps.

16. A craft substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

17. A craft substantially as hereinbefore described with reference to Figures 1 and 3 of the accompanying drawings.

18. A craft substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

19. A craft substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

20. A craft substantially as hereinbefore described with reference to Figure 6 of the accompanying drawings.

21. A craft substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings.

22. A craft substantially as hereinbefore described with reference to Figure 8 of the accompanying drawings.

J. A. BOUTLAND,
Chartered Patent Agent.
Agent for the Applicants.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1.

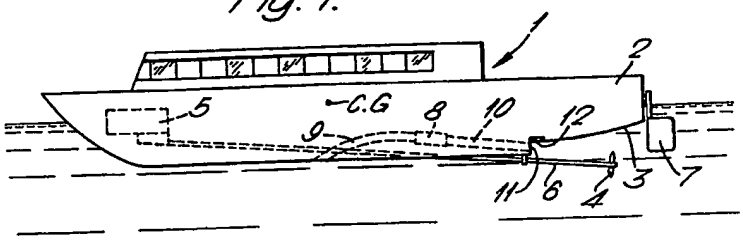


Fig. 2.

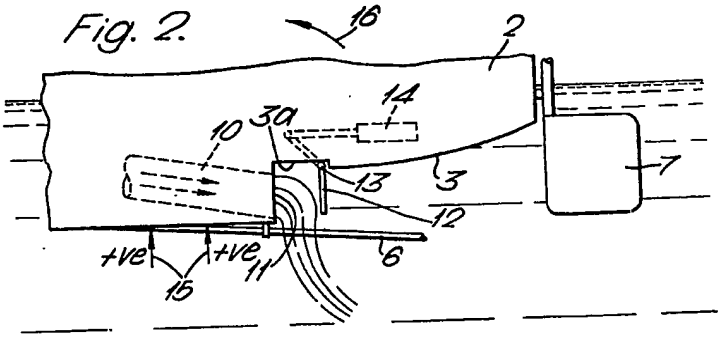
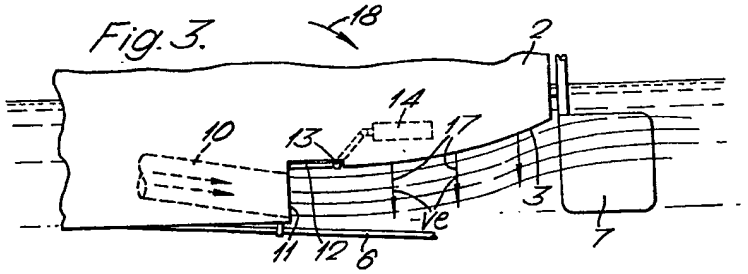


Fig. 3.



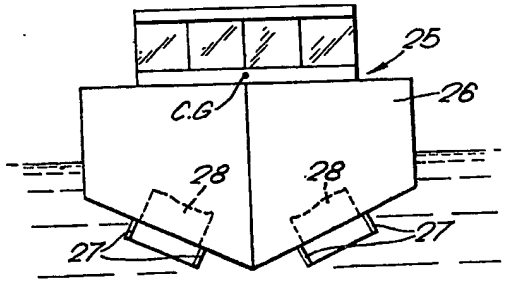


Fig. 4.

Fig. 5.

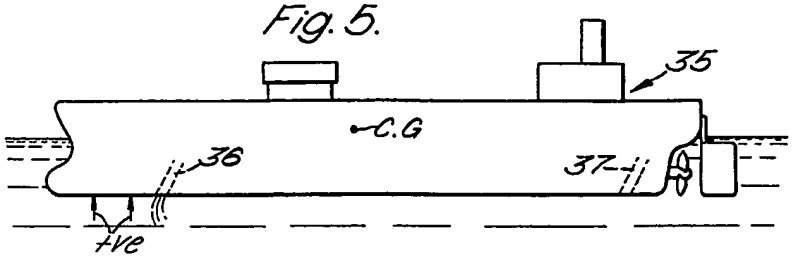


Fig. 6.

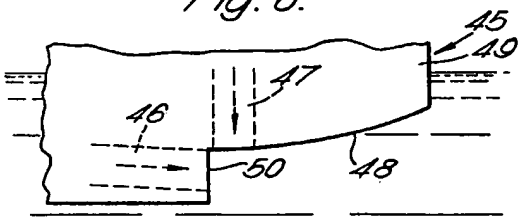


Fig. 7.

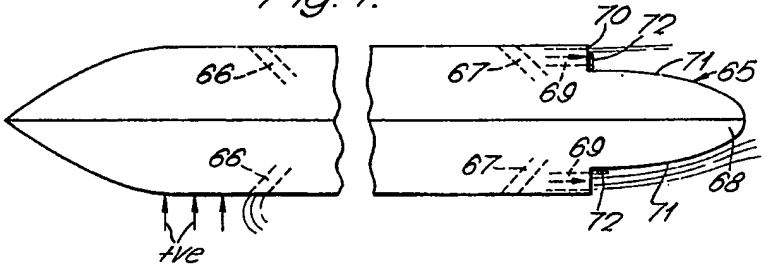


Fig. 8.